Barcelona Supercomputing Center
Centro Nacional de Supercomputación

EXCELENCIA SEVERO OCHOA

AQWATCH preparation:

First insights of NO2 pollution over Mexico City with TROPOMI

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AC group meeting

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AQ-WATCH

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AQ-WATCH

- Started in January 2020
- Coordinated by MPI (Hamburg), involving 12 partners
- General objective of AQ-WATCH : Develop a supply chain leading to the generation of several innovative downstream AQ products and services

[WP2, task 2.5]

- Objective : estim**ate surface pollutant concentrations and derive AQ indices using machine learning algorithms, satellite observations** (e.g. TROPOMI) **among other dataset** (e.g. Copernicus, ECMWF)
- Application to NO2 and aerosols.

https://earth.bsc.es/wiki/doku.php?id=projects:aqwatch

General information on TROPOMI

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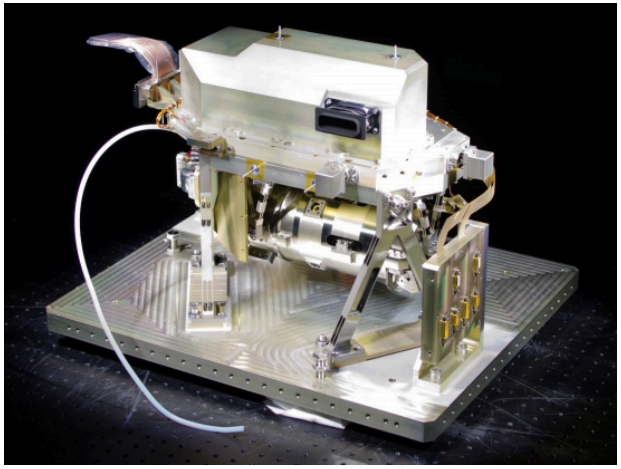
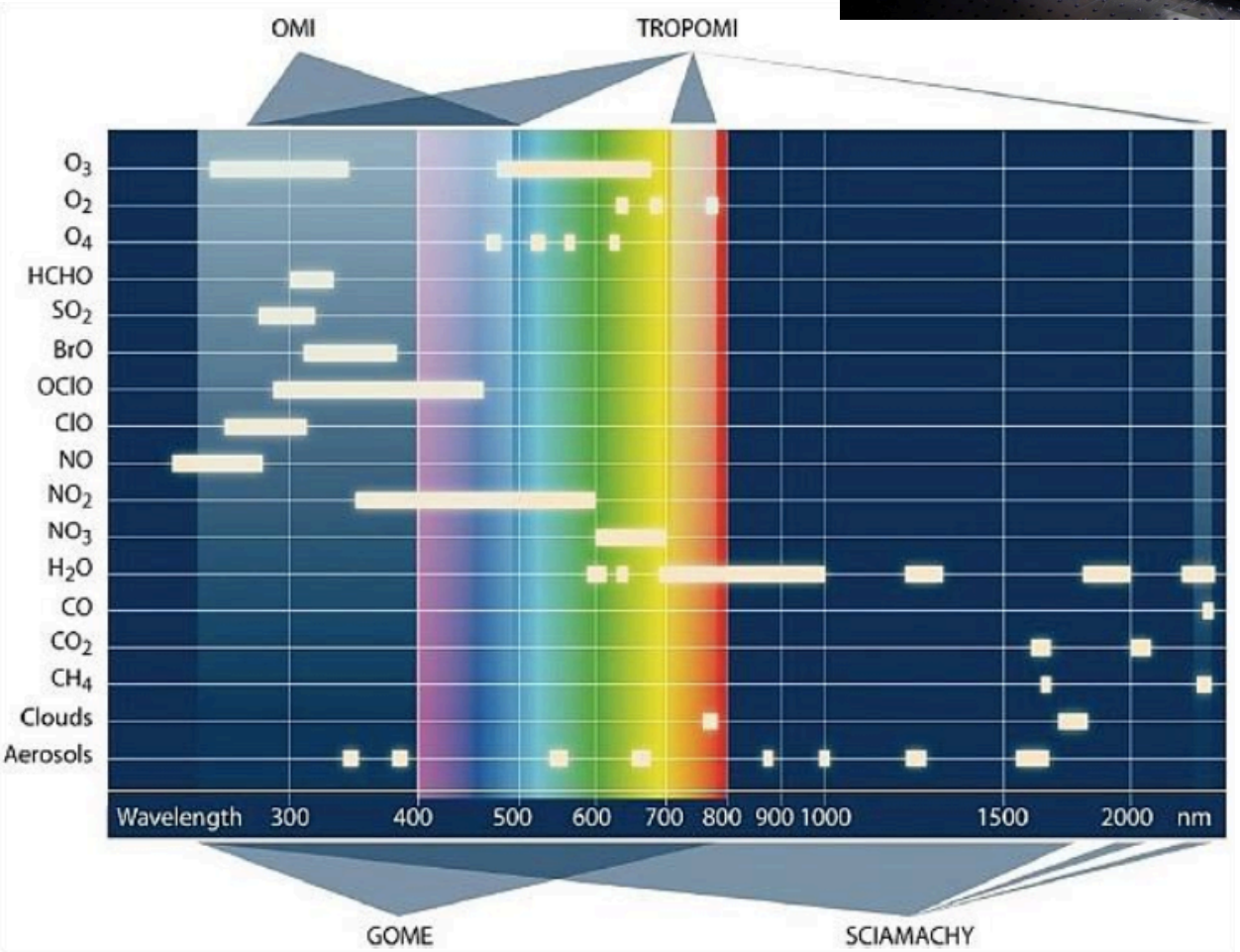
TROPOMI

- Sentinel-5 Precursor (LEO) : **fill the gap between the current records from OMI (NASA EOS Aura) and SCIAMACHY (ESA Envisat) and the operational Sentinel-4/5 missions**





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TROPOMI versus OMI

- TROPOMI combines the strengths of SCIMACHY, OMI and state of the art technologies
- Major improvement of spatial/temporal resolution, spectral resolution, sensitivity

OMI

Optical chanel	Spectral range (um)	Nadir pixel size (km2)	Max S/N ratio
UV	270-314	36x48	750
UVIS	306-500	13x24	1000

TROPOMI

Optical chanel	Spectral range (um)	Nadir pixel size (km2)	Max S/N ratio
UV	267-332	7x28	1000
UVIS	303-499	7x3.5	1500
NIR	675-775	7x3.5	500
SWIR	2305-2385	7x7	100

- Global daily coverage at 13h30 LST
- Statistics on (lon-lat) spatial resolution calculated over one orbit :

Mean :	6.1±2.7	x	5.6±0.1 km2	(area = 34 km2)
Min :	3.6	x	5.2 km2	(20 km2)
Max :	15.1	x	5.6 km2	(84 km2)
p50 :	5.0	x	5.6 km2	(28 km2)

TROPOMI NO2 at Mexico City

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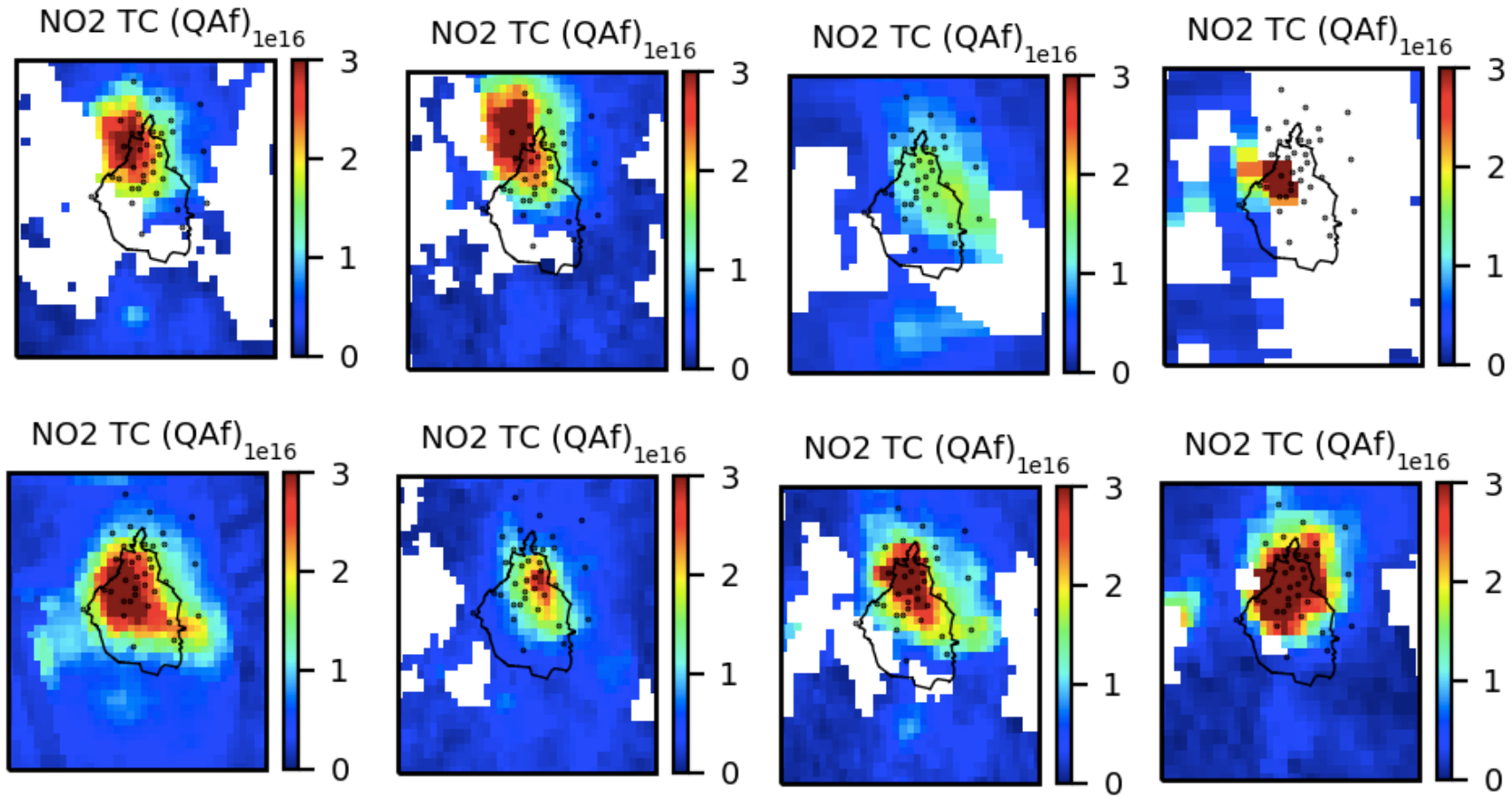
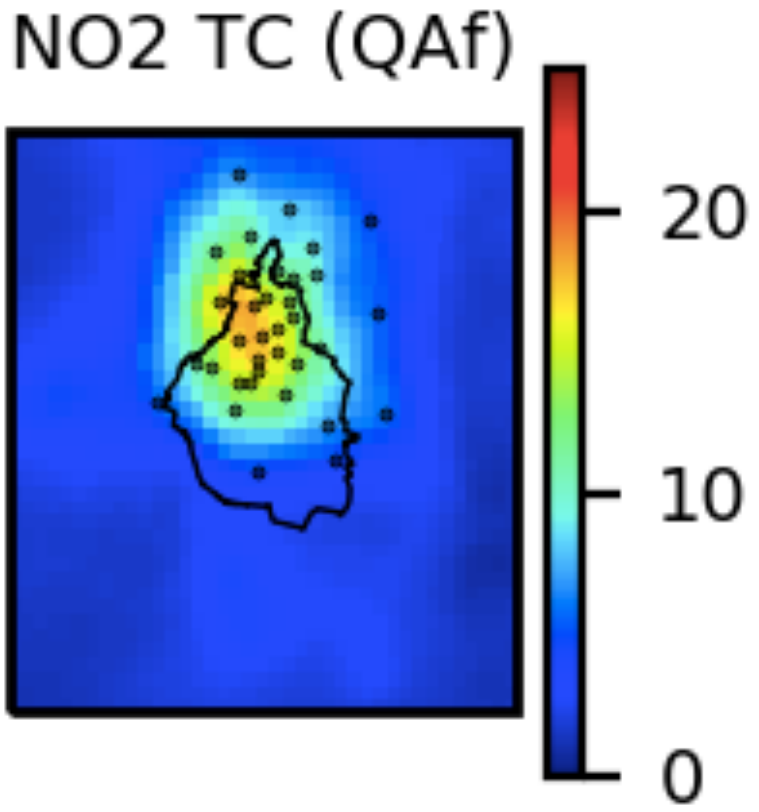
Day-to-day variability

- TROPOMI L2 products merged and regridded at 3 km resolution, here for several days in january :



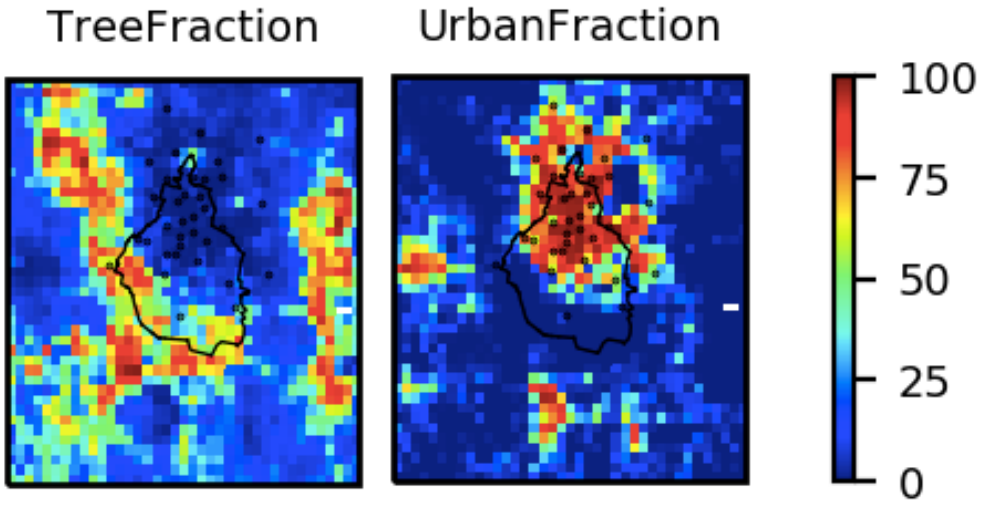
Annual average in 2019

- Many cells within Mexico City and generally only one surface station per cell
  ➔ **Strong potential for investigation intra-urban variability in large megacities like Mexico City**

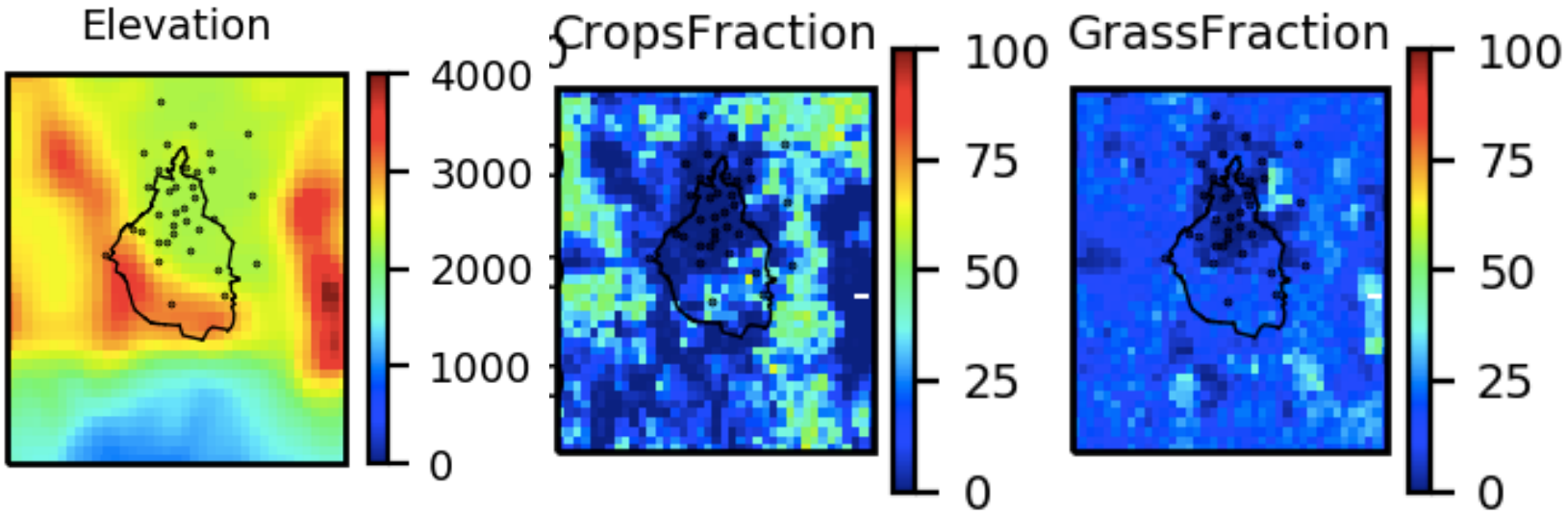


Orography and land cover

- Complex orography with mountains at west/south and volcano at east (Popocatépetl)
- Crops represents 50% of the land cover in many areas around the cities (and moutains)

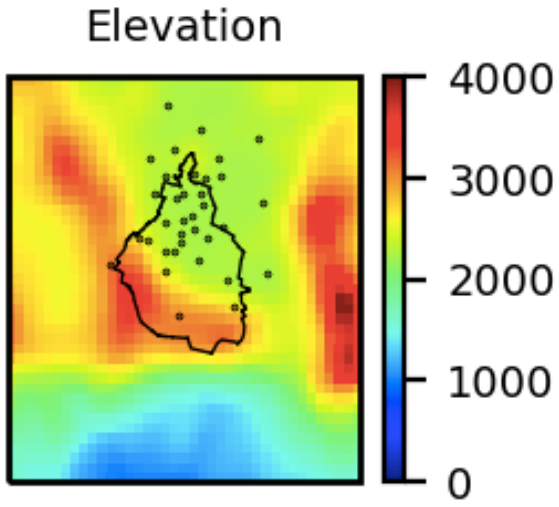


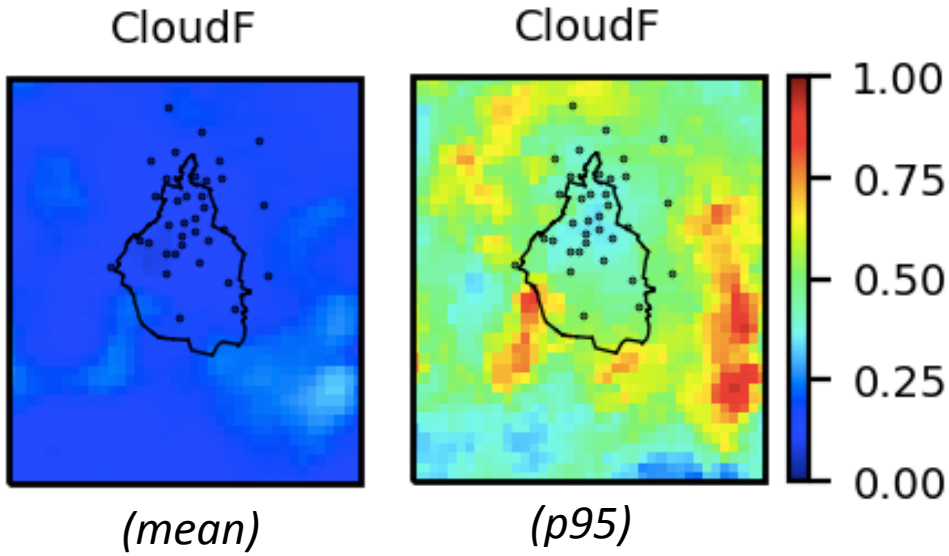
(from Copernicus Land Monitoring Service)



Cloud fraction

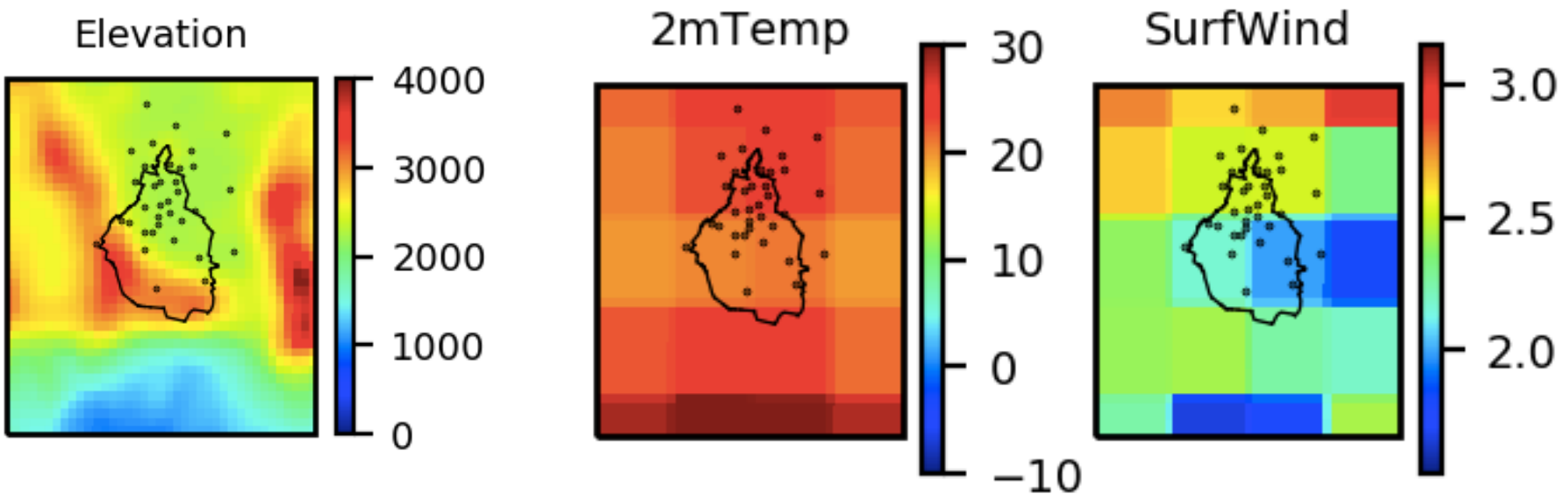
- Relatively mean low cloud radiance fraction (CRF) in Mexico City area. Highest value of CRF close to Popocatépetl (not only cloud but also eruption plumes?)





Meteorology

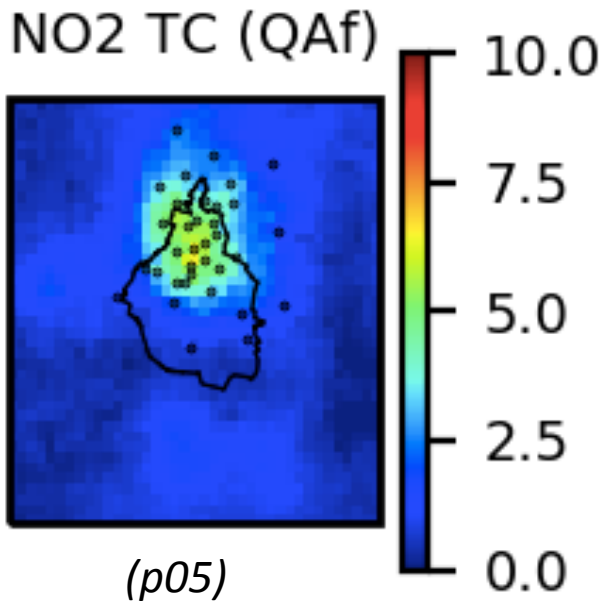
- ERA5 meteorology quite coarse (about 30 km) at the megacity scale
- Maybe poor quality in an area of such complex orography



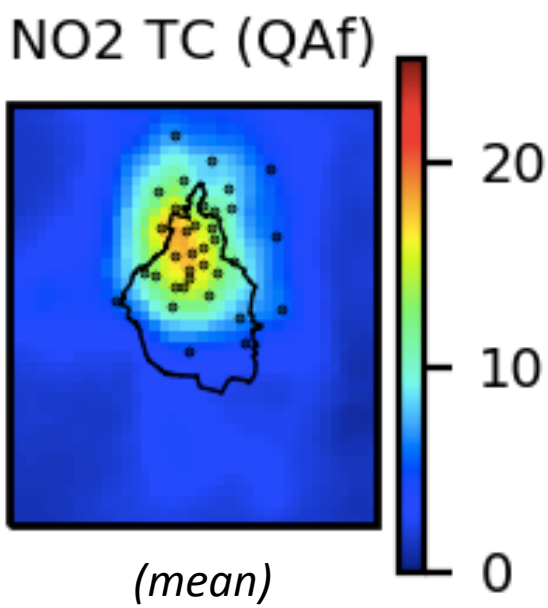
Mean versus extreme values

Around the city center of Mexico City :

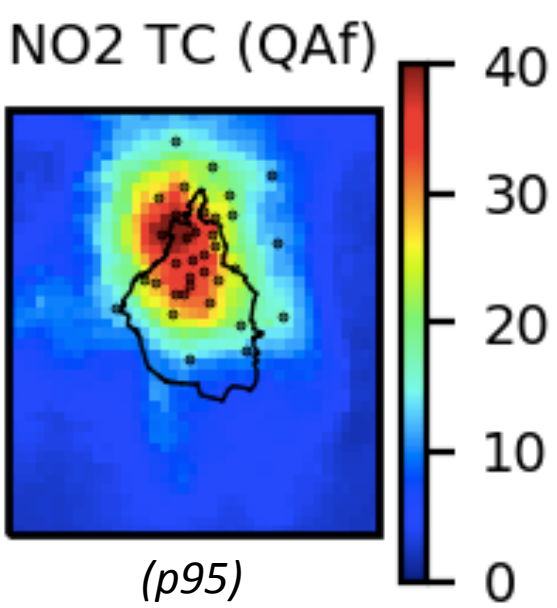
- Mean NO2 tropospheric column of about : 18e15 molec/cm2
- 5th percentile : 5e15 molec/cm2
- 95th percentile : 40e15 molec/cm2



(p05)



(mean)



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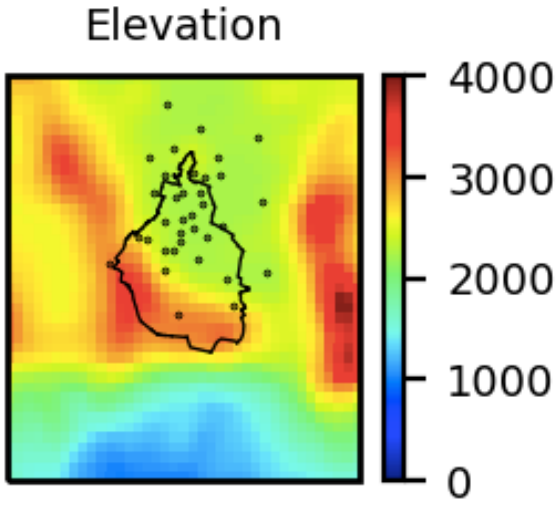
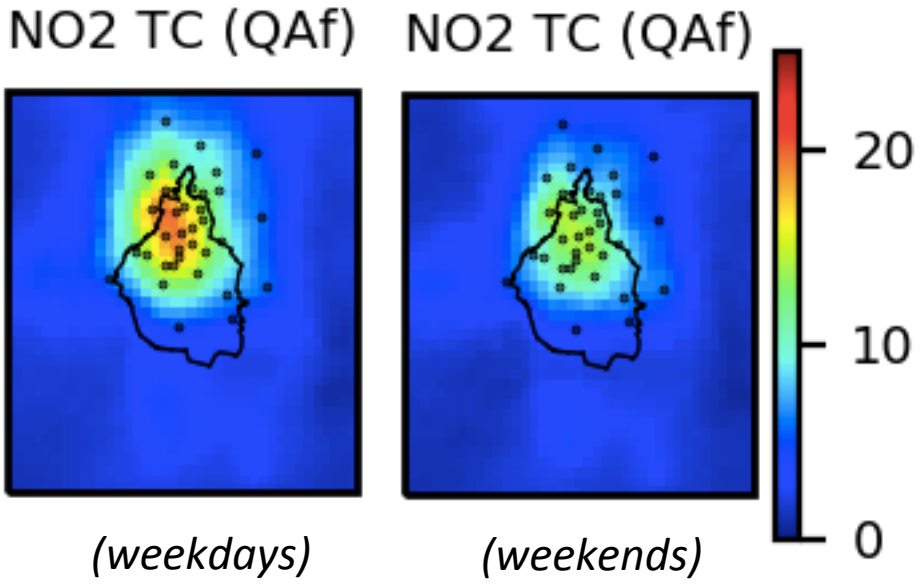
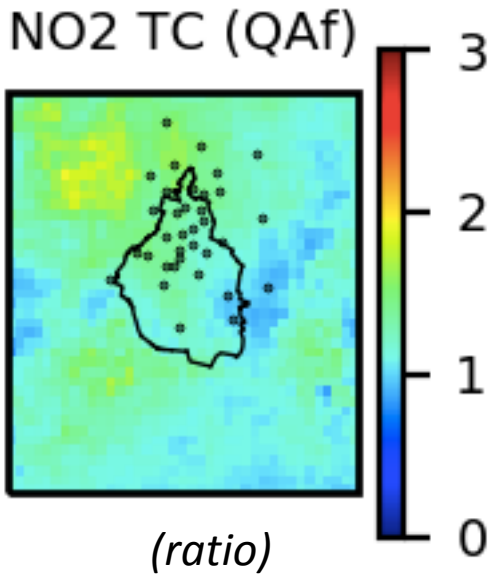
Weekdays and weekends

- NO2 tropospheric columns about 1.3 higher during weekdays than during weekends
- Surprisingly, highest ratio (about 1.9) is in north-west of Mexico City

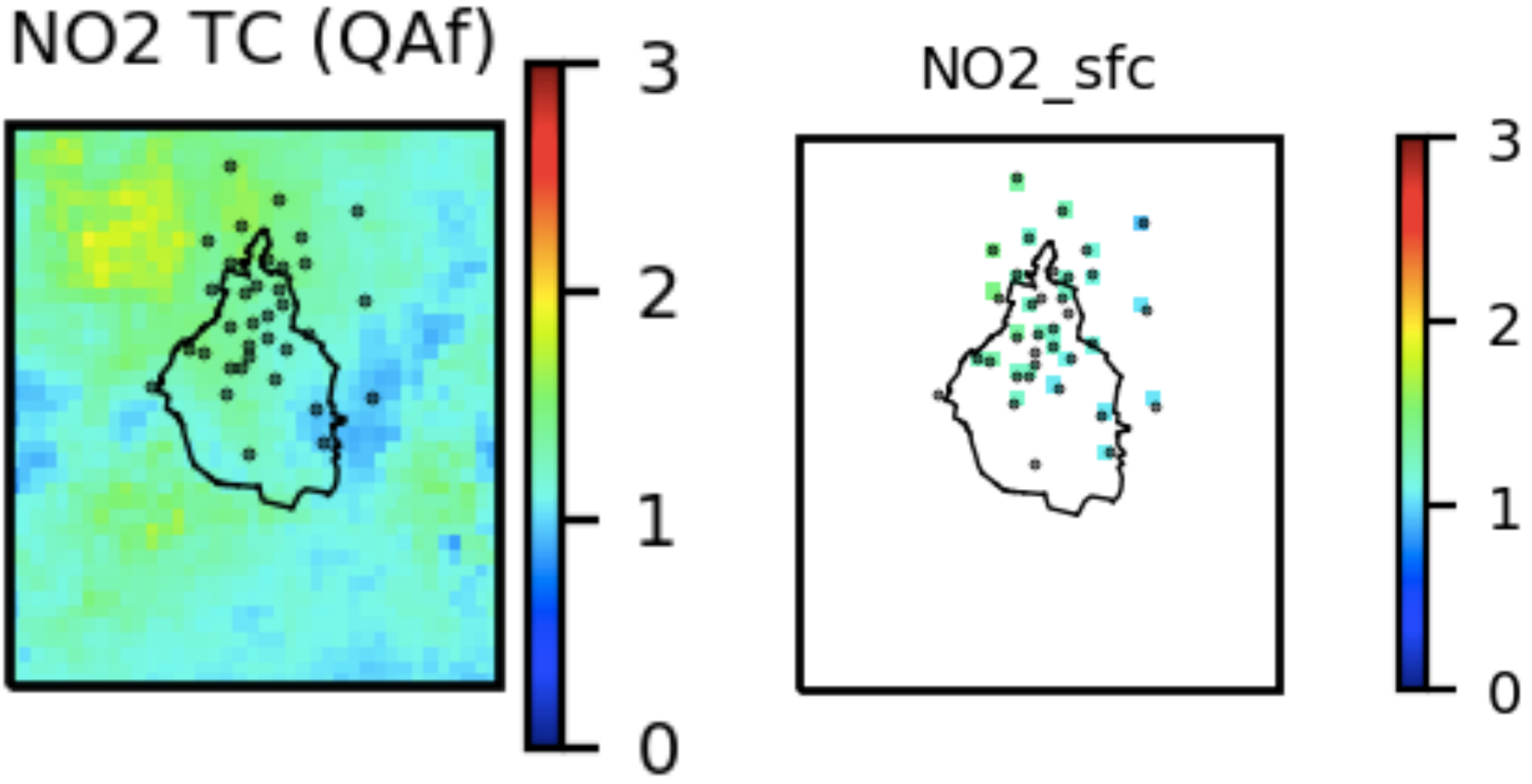






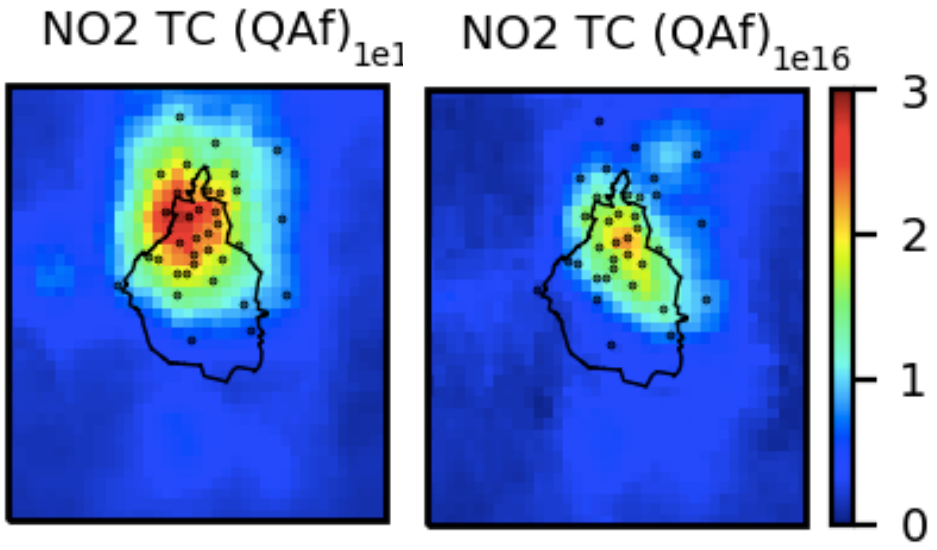
Weekdays and weekends

- Weekdays-over-weekend ratio quite consistent with surface observations (colocated in time with TROPOMI)

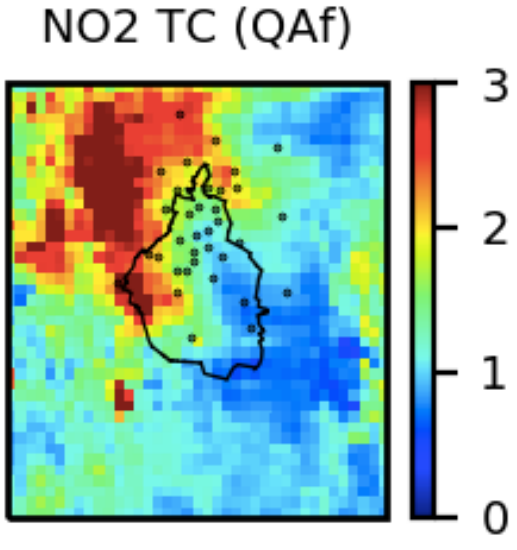


Weekdays and weekends

- Focusing on shorter periods, the spatial pattern of the ratio can be strongly accentuated
- Here for January : much higher ratio in north-west part (but less days taken into account, so representativeness maybe deteriorated...)



(weekdays) *(weekends)*

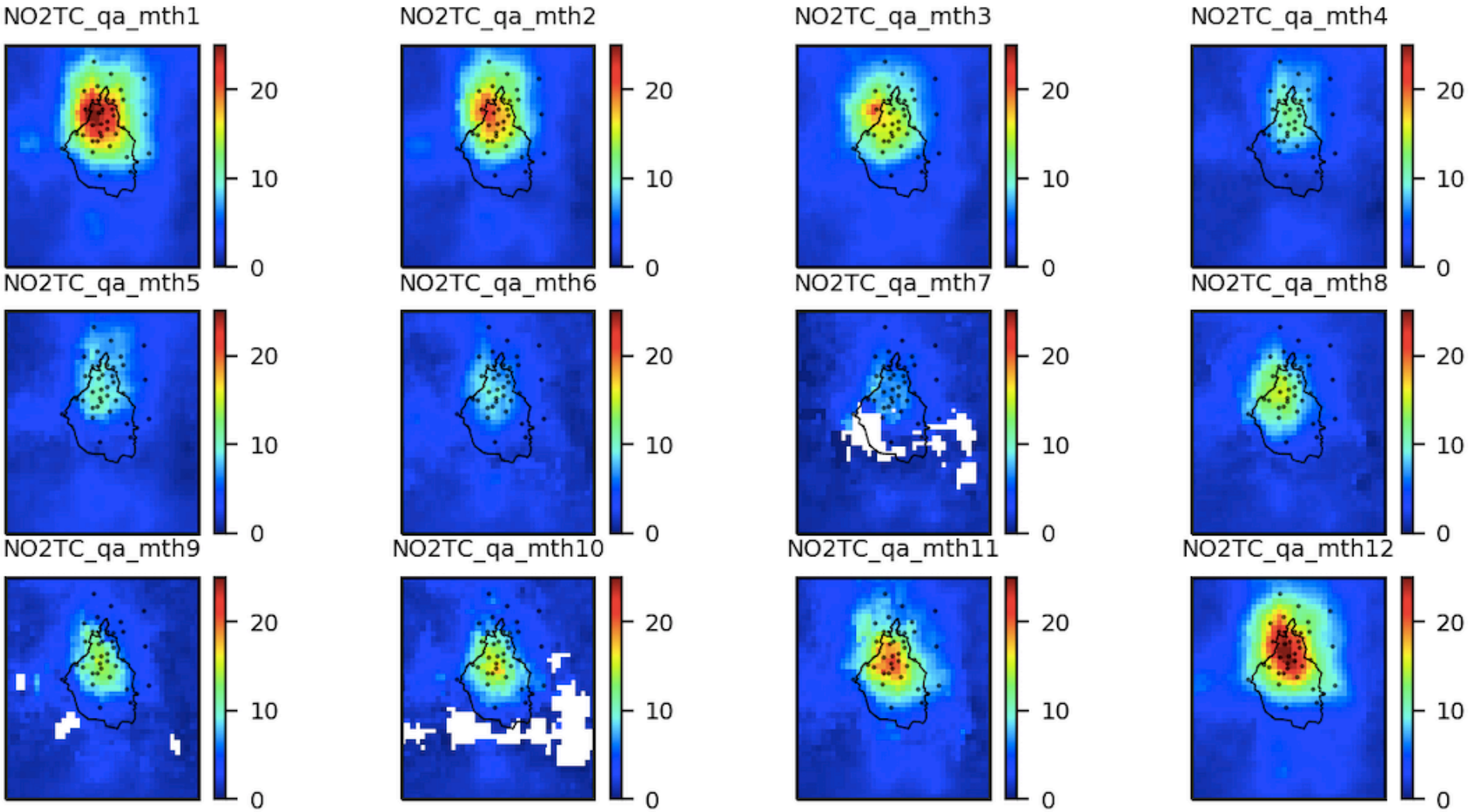


(ratio)

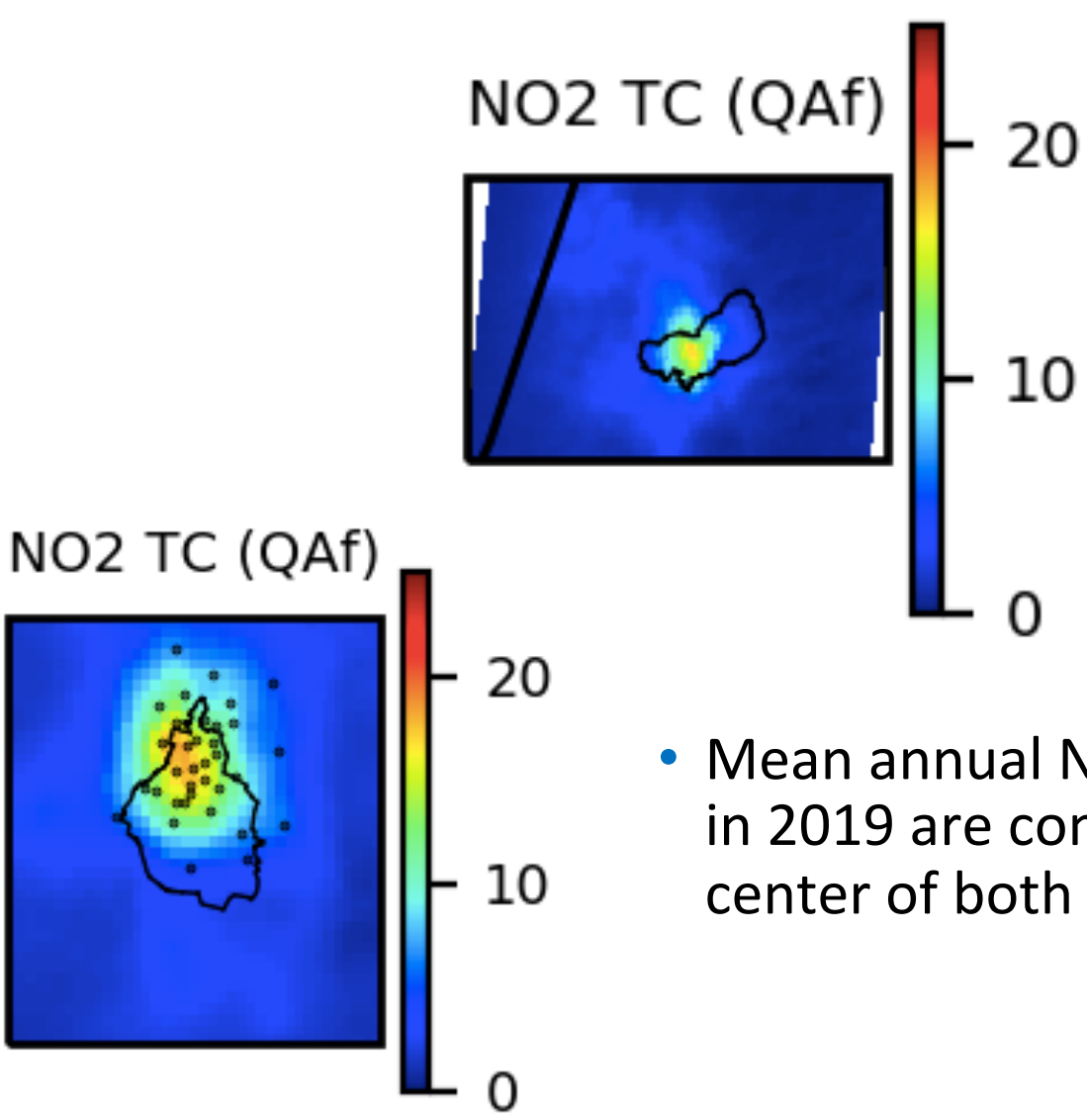
Monthly variability

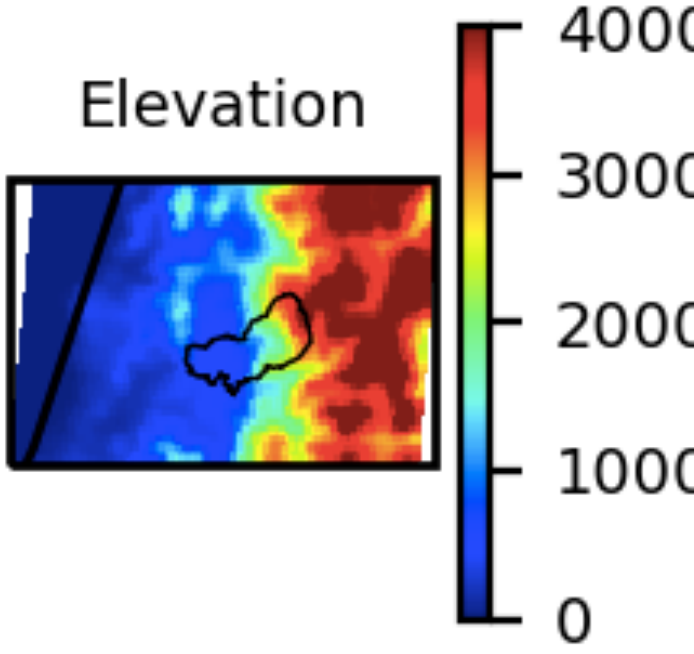
- Very strong seasonal variability

(NB : data gaps maybe partly to TROPOMI netcdf still missing on esarchive)



Mexico versus Santiago de Chile

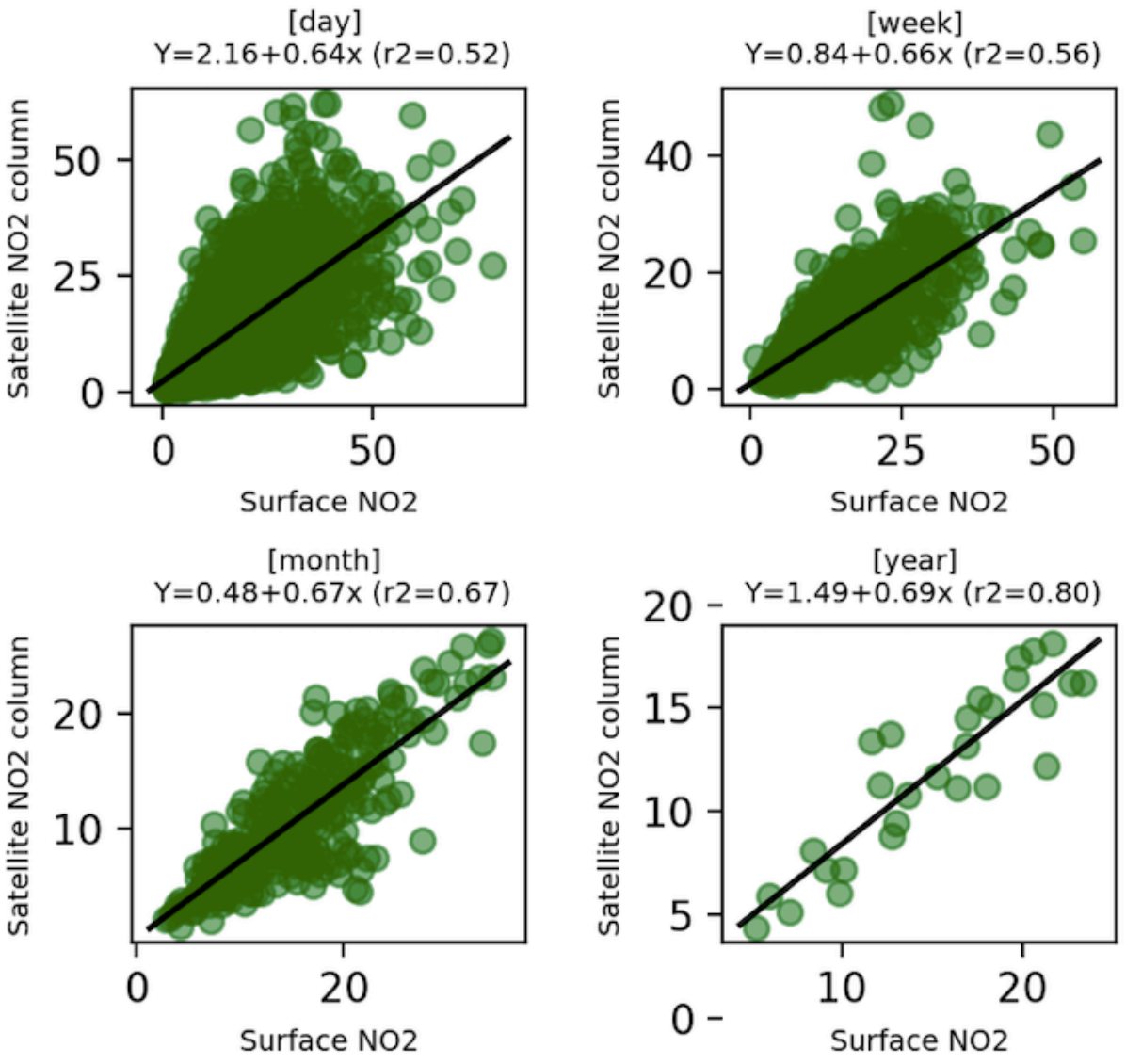




- Mean annual NO2 tropospheric columns in 2019 are comparable in the city center of both cities

Surface versus columns at Mexico City

- Surface NO2 concentrations are quite well correlated with NO2 columns observed from space, especially when considering larger temporal scales



Inference of surface NO2 concentrations